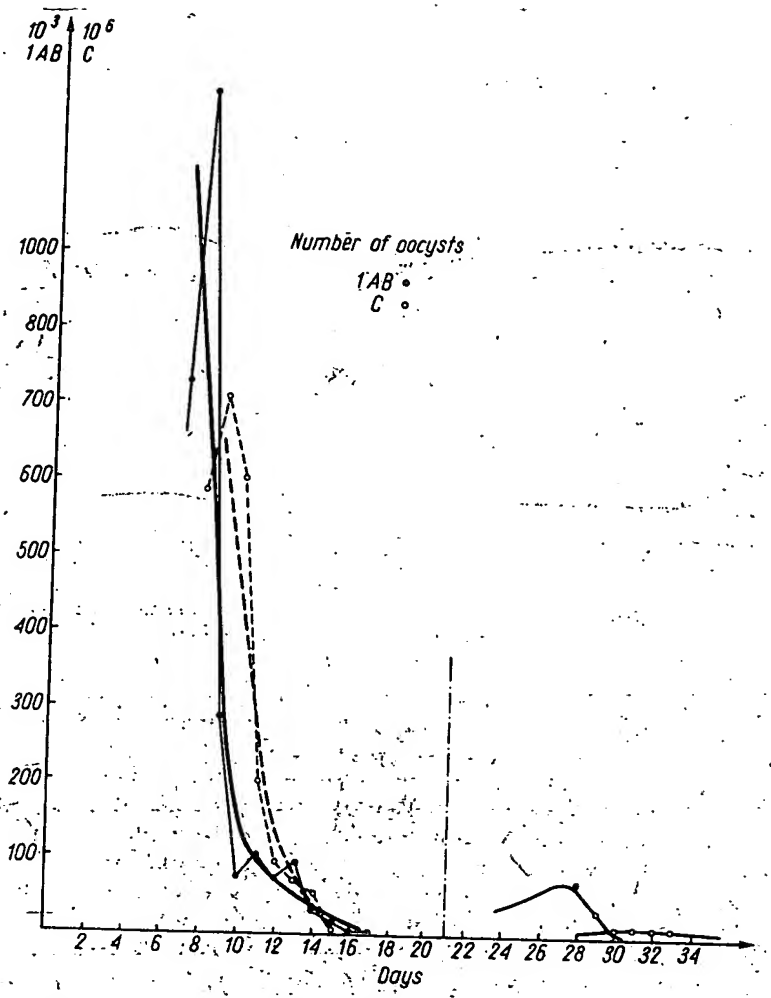


Diagram 3. Showing dynamics of changes in the number of oocysts per g droppings in chicks of Group 1 (Subgroups A, B) and the control group C in Series I. The means of graphic presentation are explained in Chapter dealing with "Material and methods".

Discussion

The only means of effective immunization of poultry against coccidiosis of caeca known so far is the infecting of susceptible individuals with appropriate doses of *E. tenella* oocysts. This method certainly reduces the sustained losses owing to the abortive course of the disease, but it does not remove the source of the infection (distributor of oocysts). From this arises the suggestion that further investigations are required to search for methods of weakening the pathogenic properties of coccidia used as immunizing material.

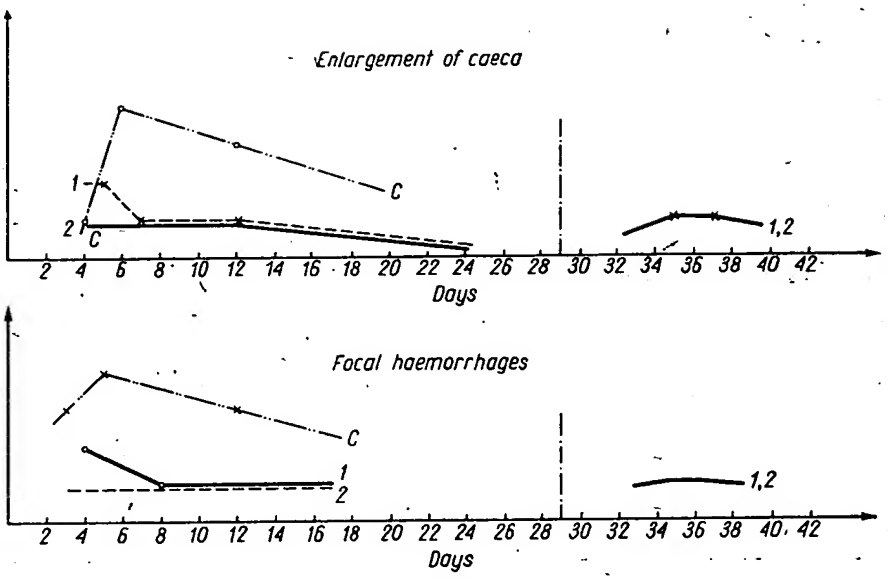


Diagram 4. Some pathological changes in caeca of experimental chicks in Series I (Groups 1, 2). The means of graphic presentation are explained in Chapter dealing with "Material and methods".

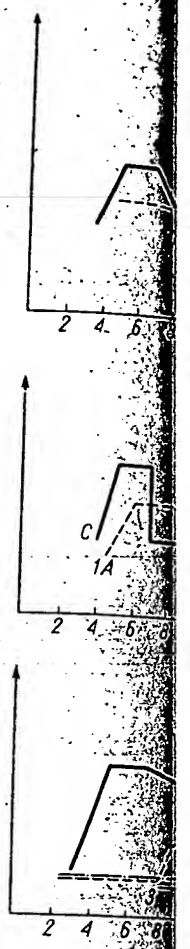
It is known (Horton-Smith 1962, Pastuszko 1973 a, b) that fowls become resistant to all-host specific coccidian species only when oocysts of the respective species have provoked a subclinical form of coccidiosis. No cross-immunity between different coccidian species has been recorded. The immunity obtained by natural means is of the nature of total or partial immunization. So it either completely inhibits the endogenous development of coccidia or only prevents development of certain stages of the life cycle. Thus, the final effect is either complete prevention of infection or its abortive asymptomatic course. Most often in practice the latter course of events has been recorded in poultry farms,

Table III

Mean body-weight gain in chicks of the Series II experiments

Group of chicks	Mean body-weights (g) recorded on experimental days					
	1st day	7th day	14th day	21st day*	28th day*	33rd day*
1	37	56	85	104	142	239
2	35	48	86	113	175	269
3	37	54	82	117	191	320
4	37	56	84	117	172	318
Control	37	54	86	96	138	195
Free of coccidia	37	56	84	144	255	379

* Data obtained from groups 1-4 include mean body-weights of birds of both subgroups together



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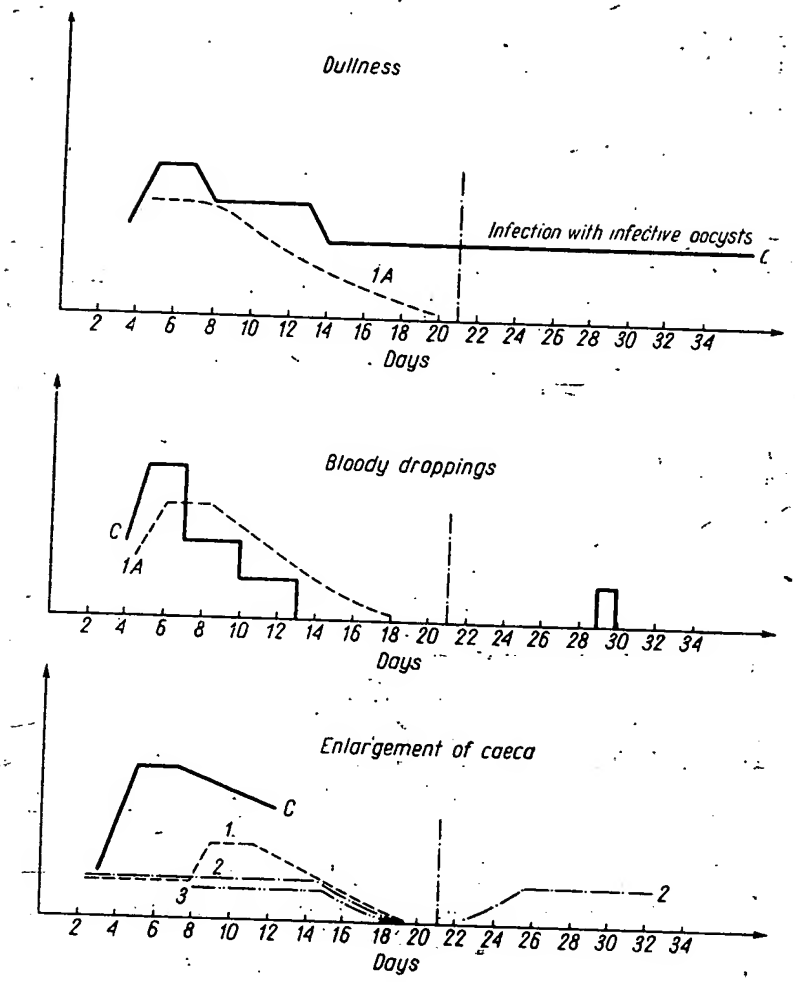


Diagram 5. Some pathological changes in experimental chicks in Series II (Groups 1–3, and the control group). The means of graphic presentation are explained in Chapter dealing with "Material and methods".

and the immunized birds are natural reservoirs and distributors of the parasite.

The immunity to coccidia, known for a long time, has not been sufficiently explored so far. The mechanism of its production has not been precisely investigated. The results of studies by many authors seem to point to schozogony forms as responsible for the production of immunity to infection of *Eimeria* sp., *E. tenella* above all. There are many reasons to suppose that schizonts of the first and second generations are the main source of antigen. It is also known (E u z é b y et al. 1967) that the lymphoid tissue of the bursa Fabricii plays an indubitable part in the production of immunity to coccidiosis in fowls, because after bursectomy the birds do not become resistant. Also the lymphoid hypertrophy

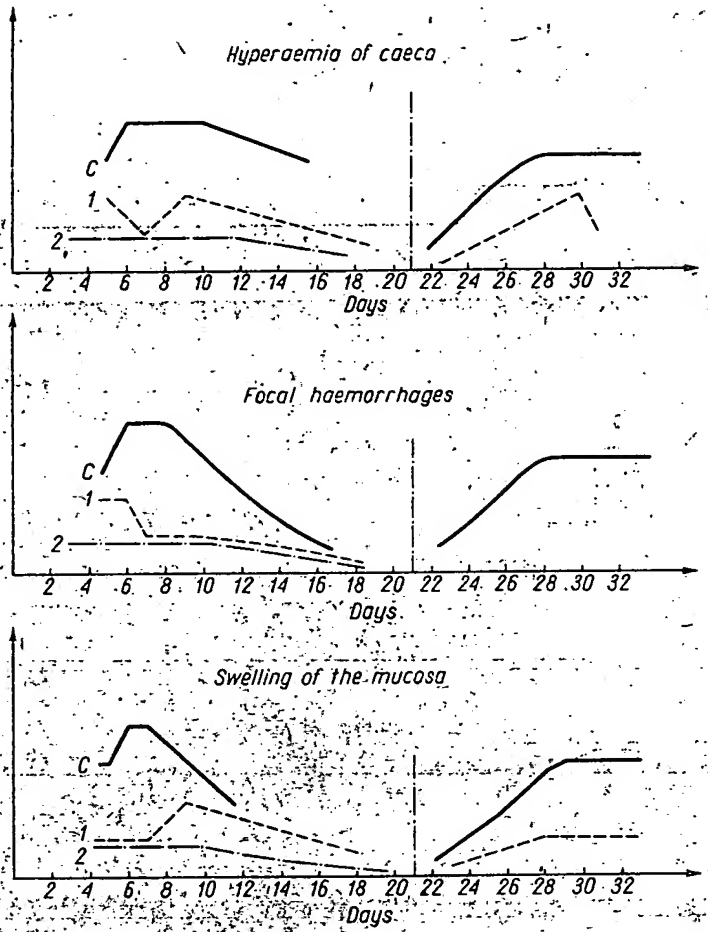
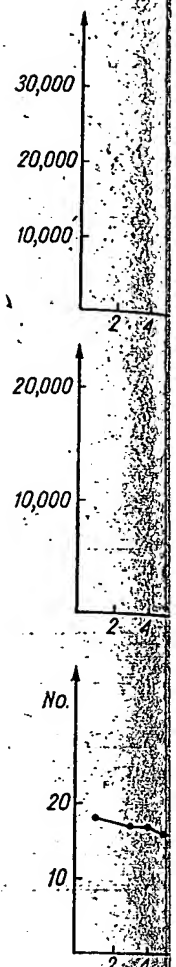


Diagram 6. Some pathological changes in experimental chicks in Series II (Groups 1, 2, and the control group). The means of graphic presentation are explained in Chapter dealing with "Material and methods".

of caeca in chicks after immunization and those suffering from coccidiosis produced by fully infective oocysts, as recorded by the present author, points to the importance of the lymphoid cell elements in this respect. The results obtained by many authors (Horton-Smith et al. 1961, Horton-Smith 1962, Burns and Challey 1959, Rose and Long 1970, Pierce et al. 1962, 1963) reveal humoral character of immunity to coccidia in fowls. The sera of immunized animals kill sporozoites and merozoites of the respective *Eimeria* species in vitro. But attempts to transfer immunity to *E. tenella* passively have, until recently, been unsuccessful. No satisfactory results have been obtained either, in attempts to induce active immunity in chicks by the use of dead antigen (solution of *E. tenella* schizonts extract).

The recent studies of the effect of ionizing rays on infective parasitic



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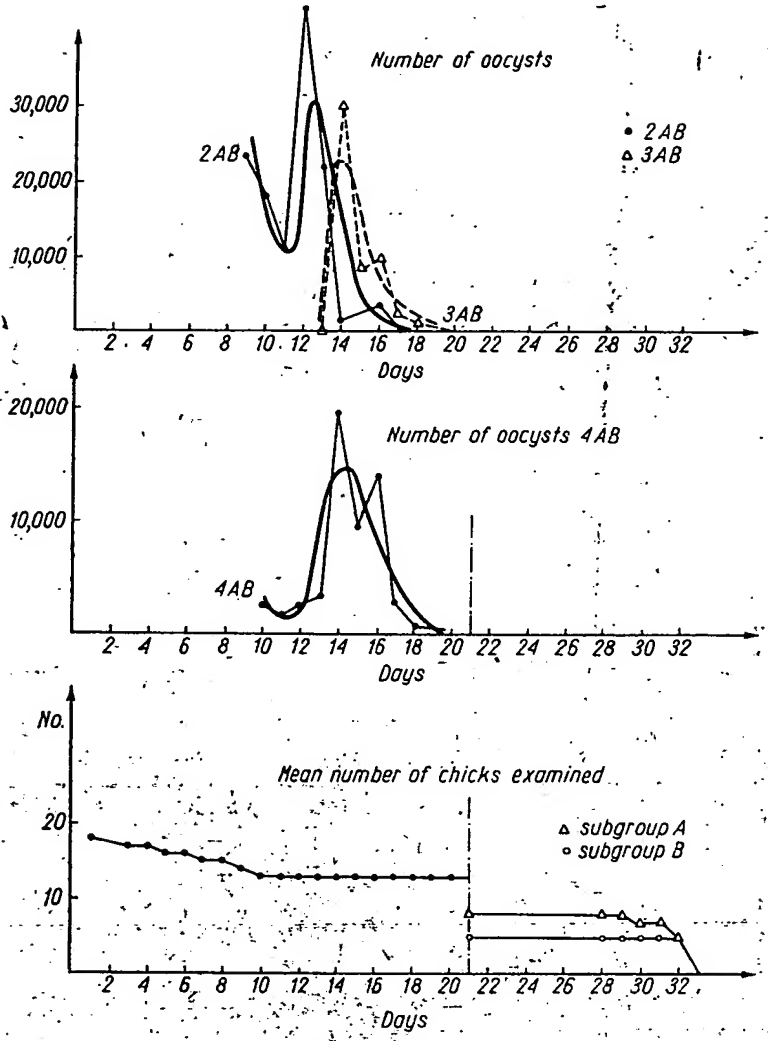

Diagram 7. Showing dynamics of changes in the number of oocysts per g droppings in chicks of Groups 2–4 (Subgroups A and B) in Series II. The means of graphic presentation are explained in Chapter dealing with "Material and methods".

forms began in 1916, when Tyzzer and Honeij started to work along this line in their studies of nematodes. Since that time many publications have appeared dealing with that problem, to mention Schawartz 1921, Levin and Evans 1942, Alicata and Burr 1949, Alicata 1951, Gould et al. 1953, Soulsby 1961. These publications mainly refer to parasitic nematodes. The studies on the effect of ionizing rays on the organisms of parasitic protozoa began later and so far not many results of these studies have been published

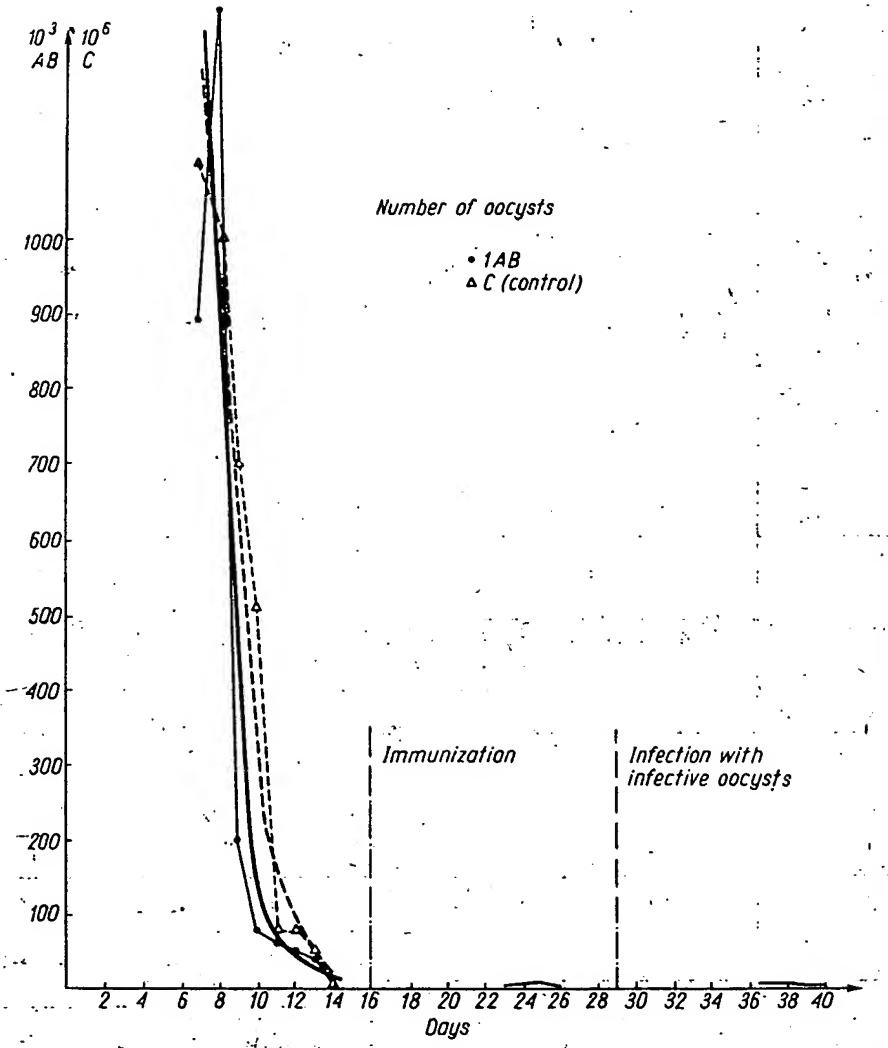

Diagram 8. Showing dynamics of changes in the number of oocysts per g droppings in chicks of Group 1 (Subgroups A and B) in Series II. The means of graphic presentation are explained in Chapter dealing with "Material and methods".

(Albanese and Smetana 1937, Waxler 1941, Hein 1963, Fitzgerald 1965, Mladenowić et al. 1966 and others). All the mentioned authors are unanimous in their opinion that the sporulating oocysts of *Eimeria* sp., particularly in the period preceding the completing of sporulation, are more susceptible than non-sporulating oocysts to the activity of ionizing rays. It has also been confirmed that the growth of the dose of radiation is accompanied by a gradual attenuation of the infectivity of oocysts, with a simultaneous preservation of their immunizing properties with regard to susceptible host organisms. The

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results of studies by certain authors, particularly Albanese and Smetana 1937, Hein 1963 and recently Paškin 1965 and Mladenowić et al. 1966, point out that in the case of exposure of *Eimeria tenella* oocysts to X-rays, the dose of radiation should exceed 10,000 R. However, attempts to find the optimum dose of X-rays or the dose of irradiated oocysts which would be the best for practical immunization of chicks have, until recently, been unsuccessful. Thus, the results of the present study seem to provide new valuable information in this respect. The present promising findings suggest the following, mainly practical conclusions.

1. The generally known resistance of coccidia, including *Eimeria tenella*, to the activity of various physical and chemical factors makes it difficult and often quite impossible to eliminate their infective forms from the breeding environment. In the search for methods of effective prevention of caecal coccidiosis in fowls, particular attention should be given to the possibility of obtaining an effective immunizing means in the form of artificially attenuated oocysts.

2. It appears from the results of the present study that the attenuation by X-rays of oocysts exposed to a dose of at least 10,000 R, the dose of administered oocysts being sufficiently high, is one of the satisfactory methods of immunization.

3. The preparation of a detailed method of producing suitably attenuated *E. tenella* oocysts for the purpose mentioned earlier, requires further detailed studies on the effect of various doses of X-rays on the mentioned oocysts and on the methods of administering the attenuated oocysts to susceptible chicks.

REFERENCES

Albanese A. A., Smetana H. 1937. Studies on the effects of X-rays on the pathogenicity of *Eimeria tenella*. *Am. J. Hyg.*, 26, 27–30.

Alicata J. E. 1951. Effects of roentgen radiation on *Trichinella spiralis*. *J. Parasit.*, 37, 495–501.

Alicata J. E., Burr G. O. 1949. Preliminary observations on the biological effects of radiation on the life cycle of *Trichinella spiralis*. *Science, N. Y.*, 109, 595–596.

Burns W. C., Challey J. R. 1959. Resistance of birds to challenge with *Eimeria tenella*. *Expl. Parasit.*, 8, 515.

Euzéby J., Caeiro V., Pastuszko J. 1967 a. Etudes physio-pathologiques sur la coccidiose caecale du Poulet. 2e Note: Modifications histologiques des caecums, de la bourse de Fabricius et de la rate de Poussins primo-infectés et ré-infectés par *E. tenella*. *Bull. Soc. Sci. vét. Méd. comp. Lyon*, 69, 197.

Euzéby J., Caeiro V., Pastuszko J. 1967 b. Etudes physio-pathologiques sur la coccidiose caecale du Poulet. 3e Note: Essais d'immunnisation passive contre la coccidiose caecale par administration de broyats de caecums, de rate et de la bourse de Fabricius prélevés chez des sujets immuns. *Bull. Soc. Sci. vét. Méd. comp. Lyon*, 69, 201–205.

Fitzgerald P. R. 1968. Effects of ionizing radiation from cobalt-60 on oocysts of *Eimeria bovis*. *J. Parasit.*, 54, 233–240.

Gould S. E., Van Dyke J. G., Gomberg H. J. 1953. Effect of X-rays on trichina larvae. *Am. J. Path.*, 29, 323–337.

Hein H. 1963. Vaccination against infection with *Eimeria tenella* in broiler chickens. *Proc. 17. Internat. Vet. Congr. (Hannover, Aug. 14–21)*, 2, 1443–1452.

Hein H. 1968. The pathogenic effects of *Eimeria acervulina* in young chicks. *Expl. Parasit.*, 22, 1–11.

Horton-Smith C. 1962. Resistencia hacia drogas anticoccidioideas inducida

experimentalmente en un cultivo de laboratorio de *Eimeria tenella*. *Mem. II Cong. Mund. Avicult., Mexico*, 483–489.
Horton-Smith C., Beattie J., Long P. L. 1961. Resistance to *Eimeria tenella* and its transference from one caecum to the other in individual fowls. *Immunology*, 4, 111–121.
Klimeš B., Orel V. 1969. Investigation of genetic resistance to coccidiosis. I. Selection response of chickens to infection by *Eimeria tenella*. *Acta vet. Brno*, 38, 5–57.
Leathem W. D., Burns W.C. 1968. Duration of acquired immunity of the chicken to *Eimeria tenella* infections. *J. Parasit.*, 54, 227–232.
Levin A. J., Evans T. C. 1942. The use of roentgen radiation in locating an origin of host resistance to *Trichinella spiralis* infections. *J. Parasit.*, 28, 477–483.
Long P. L. 1968. The effect of breed of chickens on resistance to *Eimeria* infections. *Br. Poult. Sci.*, 9, 71–78.
Long P. L. 1970. Anticoccidial drugs: factors affecting pathogenicity of avian coccidia. *Expl. Parasit.*, 28, 4–10.
Mladenović Ž., Šibalić S., Slavica M. 1966. Mogučnost zaštite pilića od cekalne kokcidioze vakcinom sa zračenim oocistama. *Vet. Glasn.*, 7, 527–530.
Paškin P. J. 1965. Dejstvie rentgenovskih lučej na oocisty kokcidij. *Materialy XIV Konfer. Leningr. Vetinstituta*, 180–182.
Pastuszko J. 1973a. Kokcydioza jelit ślepych wywoływana u kura domowego *Gallus gallus domesticus* (L.) przez *Eimeria tenella* (Railliet et Lucet, 1891) Fantham, 1909. I. Etiologia i patogeneza. *Wiad. parazyt.*, 19, 657–672.
Pastuszko J. 1973b. Kokcydioza ślepych wywoływana u kura domowego *Gallus gallus domesticus* (L.) przez *Eimeria tenella* (Railliet et Lucet, 1891) Fantham, 1909. II. Patologia, epizootiologia i zjawiska odpornościowe. *Wiad. parazyt.*, 19, 673–687.
Pierce A. E., Long P. L., Horton-Smith C. 1962. Immunity to *Eimeria tenella* in young fowls (*Gallus domesticus*). *Immunology*, 5, 129–152.
Pierce A. E., Long P. L., Horton-Smith C. 1963. Attempts to induce a passive immunity to *Eimeria tenella* in young fowls (*Gallus domesticus*). *Immunology*, 6, 37.
Reid W. M., Johnson J. 1970. Pathogenicity of *Eimeria acervulina* in light and heavy coccidial infections. *Avian Dis.*, 14, 166–171.
Rose M. E. 1967. Immunity of *Eimeria brunetti* and *Eimeria maxima* infections in the fowl. *Parasitology*, 57, 363–370.
Rose M. E. 1971. Immunity to coccidiosis protective effect of transferred serum in *E. maxima* infection. Parasitology, 62, 11–25.
Rose M. E., Long P. L. 1970. Resistance to *Eimeria* infections in the chicken, the effects of thymectomy, buresectomy, whole body irradiation and cortisone treatment. *Parasitology*, 60, 291–299.
Schwartz B. 1921. Effects of X-rays on trichinae. *J. agric Res., U. S. Dept. Agric.*, 20, 845–854.
Soulsby E. J. L. 1961. Zjawiska immunologiczne w przebiegu inwazji robaków pasożytniczych. Warszawa, PAN, BK i DKN, 1–62.
Tyzzer E. E., Honeij J. A. 1916. The effects of radiation on the development of *Trichinella spiralis* with respect to its application to the treatment of other parasitic diseases. *J. Parasit.*, 3, 43–56.
Waxler S. H. 1941. Immunization against cecal coccidiosis in chickens by the use of X-ray attenuated oocysts. *J. Am. vet. med. Ass.*, 99, 481–485.

STRESZCZENIE

W poszukiwaniu metody skutecznego uodparniania kurcząt przeciwko kocydiozie autorka wykonała dwie serie doświadczeń, w których zarażała do wola dwutygodniowe kurczęta oocystami *Eimeria tenella*, poddanymi uprzednio działaniu różnych dawek promieni X. Kurczęta trzech grup (po 16) serii I otrzymały jednorazowo lub dwukrotnie oocysty, napromieniowane odpowiednio dawkami 10, 20 i 30 tys. R. Po upływie od-

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powiedniego czasu kurczęta te, jak również ptaki grupy kontrolnej, nie poddane immunizacji, otrzymały w pełni inwazyjne oocysty *E. tenella*. W każdym przypadku jedna dawka oocyst wynosiła 100 000. W serii II kurczęta czterech grup (po 18) otrzymały jednokrotnie dawkę 75 000 oocyst, napromieniowanych odpowiednio dawkami 15, 20, 25 i 35 tys. R, następnie jedna z podgrup każdej grupy została zarażona w pełni inwazyjnymi oocystami w indywidualnej dawce 140000, druga zaś przez kontakt z chorymi kurczętami. Grupa kontrolna otrzymała wyłącznie oocysty o pełnej inwazyjności.

Kurczęta obu grup kontrolnych wykazywały spodziewany ostry i ciężki, typowy przebieg kokcydiozy, przy czym śmiertelność wynosiła 86,4% (Seria I, 40 dni obserwacji) i 80% (seria II, 33 dni). Ptaki immunizowane, z wyjątkiem tych, które otrzymały oocysty, napromieniowane dawką 15000 R, wykazywały w pozostałych grupach obu serii lekki, niekiedy poronny przebieg kokcydiozy, przy czym liczba wydalanych przez nie oocyst w odchodach była znacznie mniejsza w porównaniu z grupami kontrolnymi. Dwukrotna immunizacja w serii I powodowała zahamowanie schozogonii i gametogonii, co przejawiało się w braku oocyst w odchodach. Ponadto objawy chorobowe były tym słabsze, zaś zahamowanie endogennego cyklu rozwojowego kokcydiów było tym znaczniejsze, im wyższa była, w warunkach doświadczenia, dawka promieni zastosowana do osłabienia oocyst. Badania sekcyjne kurcząt padłych i zabitych doświadczalnie potwierdziły rolę elementów komórkowych w procesie powstawania odporności przeciwko kokcydiozie. Autorka zauważyła też, że średnie przyrosty wagi ciała u kurcząt, zarażonych w pełni inwazyjnymi oocystami były wyraźnie wyższe u ptaków immunizowanych niż u kontrolnych.